

**DEVICE FOR STORAGE OF MULTIPOINT DATA, PARTICULARLY  
FOR AN ARITHMETIC AND LOGIC UNIT OF A DIGITAL  
SIGNAL PROCESSING PROCESSOR**

**Field of the Invention**

The invention relates to devices for the storage of multipoint data, and particularly to a system of registers that can be addressed by an arithmetic and logic unit of a kernel of a digital signal processor (DSP), and including reading the contents of some of these registers.

**Background of the Invention**

Conventionally, a processing kernel may manage 16 registers that are grouped together to form a storage device, for example. The purpose of these registers is to store data that can be used in different operations. The storage device comprises a number of output ports (or read ports), for example 8. Consequently, up to eight registers can be read in one cycle of a clock signal controlling the speed of the processing kernel. And the same register may be read on the eight output ports.

In general, each output port (or read port) is associated with a path gate formed for example of two complementary MOS transistors controlled on their grids. Each register comprises a number of memory points, for example forty, to store 40-bit data. Since each memory point can be read on the eight read ports simultaneously, it is associated with eight path gates. Each of these

path gates controls one line on which the 16  
corresponding bits of the 16 registers are connected.  
Thus, a large capacity amplifier is provided to control 8  
output ports behind 8 path gates. Since the capacitance  
5 of this large amplifier as seen on its input is high, an  
inverter is arranged between this amplifier and the  
memory point to protect it.

However, since 16 registers are connected on  
each read port, the total capacitance of the read port is  
10 very high (capacitance of the read port itself added to  
the 16 path gate drain capacitances). Furthermore, in the  
worst case, when the same register is read on the 8 read  
ports, its inverter sees 8 lines each connected to 16  
registers. And in this configuration, the total  
15 capacitance as seen by the inverter associated with a  
register is composed of 8 line capacitances added to  
128 drain capacitances of the path gate transistors.

And in this case, the gradient of the signal  
finally read on the output ports lasts for about  
20 7 nanoseconds for a 0.18 micron technology, which is a  
problem and is usually outside the required  
specifications that specify that the duration of the  
gradient shall not exceed 3 nanoseconds for this  
technology.

25 Therefore, such devices require specific signal  
amplification (buffer), which increases the complexity of  
the device from the point of view of size and  
manufacturing cost. Furthermore, power consumption of  
such a device is high when switching output ports.

### Summary of the Invention

An object of the invention is to provide a device that does not include the drawbacks described above.

5           An object of the invention is to provide a registers system comprising a smaller number of components with a much lower gradient on its output ports than in the prior art, typically 2.5 times lower, so as to generate a large time saving.

10           Another object of the invention is to provide such a system with a low current consumption.

          Another object of the invention is to provide decoding associated with this set of registers, which is much faster than the system usually used in prior art.

15           Therefore the invention provides a data storage device comprising several registers that can be addressed by address words, and connected to  $p$  output ports through connections/connecting means that can be configured in response to address words of  $p$  registers selected to read  
20 the contents of these registers on the  $p$  ports respectively.

          According to one general characteristic of the invention, all register address words contain a specific bit with a predetermined rank identical for all address  
25 words (for example the high order bit) and remaining bits, the registers are connected in pairs on each output port, and each pair of registers contains two registers with address words that only differ in the value of the said specific bit.

30           Furthermore, for each pair of registers and for each output port, the connecting means comprise a pair of first switching means that can be controlled in a

complementary manner by the specific bit in the address word of one of the two registers, and a second switching means connected to the output port considered and that can be controlled from the remaining bits of the address words of the two registers. The first two switching means are connected firstly between the corresponding two registers, and secondly between the corresponding second switching means.

Thus, according to the invention, the registers are combined in pairs and the only difference in their address words, which may be in the hexadecimal format, is in a single bit, for example the high order bit. This means that the two registers can be read through the same switching means decoded by the remaining bits of the address word. Consequently, the number of switching means attached to a read port will be halved.

Furthermore, the two switching means, in other words the switching means that are directly attached to the read ports, will be controlled much more quickly since they only concern the remaining bits in each address word, the specific bit, for example the high order bit, being used to select one of the two registers in a pair of registers directly.

According to one embodiment of the invention, the registers comprise  $m$  memory points so as to store data with  $m$  bits. Although the invention is vertically applicable for  $m = 1$ ,  $m$  is usually more than 1 and may for example be equal to 32 or 40.

The first switching means associated with a register in a pair then comprises  $m$  first elementary path gates, connected to the corresponding  $m$  memory points in the register. The first switching means associated with

the other register in the pair comprises  $m$  other first elementary path gates connected to the corresponding  $m$  memory points of this register. A first elementary path gate connected to a memory point of the register is  
5 controlled in a complementary manner with respect to the other first elementary path gate connected to the corresponding memory point of the other register. Furthermore, the second switching means comprises  $m$  second elementary path gates, connected between the said  
10 output port considered and  $m$  pairs formed from  $s$  elementary path gates and the other first elementary path gates.

According to one embodiment of the invention, the device comprises a first elementary inverter  
15 connected between each memory point of a register and the  $p$  first elementary path gates associated with this register, and a second elementary inverter connected between each second elementary path gate connected to an output port and the pair formed by the first elementary  
20 path gate and the other first elementary path gate associated with the other register in the pair of registers.

For example, each first elementary path gate, and each other first elementary path gate may be formed  
25 by pairs of complementary MOS transistors. The grids of two opposite types of transistors (NMOS transistor and PMOS transistor), one belonging to one pair and the other belonging to the other pair, are connected together to enable complementary control of the first elementary path  
30 gate and of the other first elementary path gate. The first switching means associated with the two registers in a pair are located close to each other, in order to

minimize the size of the device advantageously made in the form of an integrated circuit.

### **Brief Description of the Drawings**

5 Other advantages and characteristics of the invention will become clear after reading the detailed description of an embodiment that is in no way limitative, and the attached drawings on which:

Figure 1 is a schematic diagram illustrating an  
10 embodiment of a storage device according to the invention;

Figure 2 is a schematic diagram illustrating several details of the device in Figure 1;

Figure 3 is a schematic diagram illustrating  
15 coupling of pairs of registers in the device according to the invention;

Figure 4 is a schematic diagram illustrating part of the device in Figures 1 and 2 in more detail; and

Figure 5 is a schematic diagram illustrating m  
20 decodings of address words in more detail.

### **Detailed Description of the Preferred Embodiments**

In Figure 1, the reference DS denotes a data storage device formed of a set of registers R, in this  
25 case 16 registers, associated with control means/unit CTL to address some of these registers to read their contents on a number of output ports, in this case 8 output ports PL0 - PL7. In this case, each of the 16 registers is a 40-memory point register, therefore capable of storing  
30 40-bit data. Consequently, each of the output ports (or read ports) comprises 40 bit lines. Furthermore, the control means/unit CTL in this case are managed by a

digital signal processor kernel PR, and particularly the arithmetic and logic unit DU of this processor.

Figure 2 shows the different memory points  $R_j.i$ , where  $i = 0$  to 39, on each register  $R_j$ , where  $j = 0$  to 15. Furthermore, all memory points with the same index  $i$ , where  $i = 0$  to 39, are connected to the 8 bit lines  $PL0.i - PL7.i$  of the 8 read ports  $PL0 - PL7$ . A detailed description of how these memory points are connected on these bit lines is given below.

One of the characteristics of the invention includes the grouping the registers in pairs, and consequently the corresponding memory points of these registers in pairs, as shown in figure 2. This grouping in pairs is done as a function of the value of the bits of the address word MAD used to address each register  $R_j$  ( $j = 0$  to 15). This grouping is illustrated particularly in figure 3. In this case each address word MAD contains 4 bits, since there are 16 registers. In the case shown, one of these bits, namely the high order bit reference A, is considered as being a specific bit. The remaining bits  $b_0$ ,  $b_1$  and  $b_2$  are low order bits of the address word MAD.

In general, according to the invention, the registers are connected in pairs on each output port, each pair of registers containing two registers for which the only difference between the address words is in the value of the specific bit A. Consequently, the remaining bits of the address words of the two registers in a pair are identical. Therefore, Figure 3 shows that the registers  $R_0$  and  $R_8$  will be connected together since the only difference in them is in the value of the high order bit A. The same is true for registers  $R_1$  and  $R_9$ ,  $R_2$  and

R10, R3 and R11, R4 and R12, R5 and R13, R6 and R14, R7 and R15.

Referring more particularly to Figure 4, a detailed description of the mutual connection of the two registers in a pair and their connection to the different output ports will now be described. For simplification reasons, Figure 4 shows only memory point R0.0 of register R0, and memory point R8.0 of register R8. The following description for these two memory points is exactly the same for the other memory points of the registers.

In this case, each memory point is formed conventionally by two inverters installed top to bottom. In this case, for memory point R0.0 and memory point R8.0 coupled to it, the configurable connections/connection means connected between each memory point and the read ports comprise a first elementary path gate 0ITA.0.0 connected to memory point R0.0 through a first elementary inverter IVA0.0. Moreover, another first elementary path gate 0ITA8.0 is connected to the memory point R8.0 through another first elementary inverter IVA8.0.

The first elementary path gate 0ITA0.0 and the other first elementary path gate 0ITA8.0 are also connected together. The common terminal between these two elementary path gates 0ITA0.0 and 0ITA8.0 is connected to a second elementary path gate 0ITB0.0 through a second elementary inverter 0IVB0.0. The second elementary path gate 0ITB0.0 is connected to the bit line PL0.0 of the read port PL0.

Figure 4 shows that the first two elementary path gates 0ITA0.0 and 0ITA8.0 are controlled in a complementary manner. Each first elementary path gate is



formed from two elementary MOS transistors, namely an NMOS transistor and a PMOS transistor. And the control gate of the NMOS transistor of the first elementary path gate 0ITA0.0 is connected to the control gate of the PMOS transistor of the other first elementary path gate 0ITA8.0. Similarly, the control gate of the PMOS transistor of the first elementary path gate 0ITA0.0 is connected to the control gate of the NMOS transistor of the other first elementary path gate 0ITA8.0.

And the control gate of the NMOS transistor of the first elementary path gate 0ITA0.0 and the control gate of the PMOS transistor of the first elementary path gate 0ITA8.0 are controlled by the value of the high order bit A0 of the address word MAD0 output by control means to address the registers selected on the read port PL0, in read.

Therefore, it can immediately be seen that the value 1 for the bit A0 can be used to select memory point R0.0 while the value 0 can be used to select memory point R8.0 (in fact, the annotation A0\_n denotes the complementary value of A0). Consequently, a given logical value for bit A0 can also be used to control the first elementary path gates associated with memory points with the same logical value of their high order bit, to make them conducting. This is why the effective selection of one of the registers will be made in combination with the high order bit A, by the remaining bits of the address word. In this respect, as shown in figure 5, the control means generate the values A<sub>i</sub> and A<sub>i\_n</sub> from the high order bit A, and also the control signals rdi and rdi\_n starting from the remaining bits b0, b1, b2 of the address word MAD<sub>i</sub>.

These control signals `rdi` and `rdi_n`, for example `rd0` and `rd0_n`, will control the second elementary path gate `0ITB0.0`. Since in this case the device comprises 8 read ports, the first elementary path gates, the second elementary path gates and the second elementary inverters are repeated 8 times. More precisely, for example for bit line `PL1.0` for read port `PL1`, a first elementary path gate `1ITA0.0` connected to the first elementary inverter `IVA0.0` and another first elementary path gate `1ITA8.0` connected to the first elementary inverter `1IVA8.0` are provided. These first two elementary path gates `1ITA0.0` and `1ITA8.0` are connected together. Their common terminal is connected to the second elementary inverter `1ITB0.0` through a second elementary inverter `1IVB0.0`. The second elementary inverter `1ITB0.0` is connected to the bit line `PL10` of the read port `PL1`.

The first elementary path gates `1ITA0.0` and `1ITA18.0` are controlled in a complementary manner by bit `A1` in the address word `MAD1` dedicated to the read port `PL1`. Similarly, the second elementary path gate `1ITB0.0` is controlled from the remaining bits of this address word.

Consequently, there are major advantages with this invention. The number of elementary path gates attached to read ports is only half the number used in prior art. The control means/unit CTL, in other words the decoding stage, are much faster since in the invention only three bits (the remaining bits) are decoded, instead of 4 as in prior art. The last bit, in fact the high order bit, directly controls the first elementary inverter without any decoding being necessary.

If the same register is read simultaneously on the 8 read ports, the first corresponding elementary inverters will be acted upon. However, each first elementary inverter will only see 16 elementary path gates and 8 second elementary inverters. Furthermore, each second elementary inverter controls a bit line connected to 8 second elementary path gates. And even if the 8 read ports are used to read the contents of the same register (which is the worst case), the second elementary inverters will only see one bit line capacitance (instead of 8 in prior art) and 8 elementary path gates (instead of 128 in prior art). Consequently, the gradient of the output signal is modified and is between 2 and 3 nanoseconds instead of 7 according to prior art. As a result, no particular additional amplification is necessary, and the speed is increased by 30%. Furthermore, current consumption is reduced due to the large reduction in the global capacitance seen by the output ports on the device.

The invention is not limited to the embodiments that have just been described, but it includes all variants. Thus, it can be applied to an arbitrary number of registers with an arbitrary number of read ports. The invention is still applicable even if the number of registers is odd. In this case, a single register will be isolated and the others will be connected in pairs as described above.